NAGW-3048
Progress Report
14 December 1992

Solar System Exploration Division
National Aeronautics and Space Administration
Washington, DC 20546

Teaching, Learning, & Planetary Exploration

Principal Investigator: Robert A. Brown
Space Telescope Science Institute
(410) 516-8129

Sponsored Projects Office: Claudia Haywood
Space Telescope Science Institute
(410) 338-1534

Reporting Period: 1 May 1992 - 30 September 1992

Grant to the
Space Telescope Science Institute
3700 San Martin Drive
Baltimore, Mayland 21218

Operated by the
Association of Universities for Research in Astronomy, Inc.

Robert A. Brown
Principal Investigator

Progress Report

This report presents the progress accomplished in the first five months of the three-year grant period of *Teaching, Learning, and Planetary Exploration* (NAGW-3048).

The objectives of this project are to discover new education products and services based on space science, particularly planetary exploration. *An Exploration in Education* is the umbrella name for our education projects as they are seen by teachers and the interested public. As described in our proposal—and in our numerous writings—our approach consists of: (1) Increasing practical understanding of the potential role and capabilities of the research community to contribute to basic education using new discoveries. (2) Developing an intellectual framework for these contributions by supplying criteria and templates for the teacher's stories. (3) Attracting astronomers, engineers, and technical staff to the project and help them form productive education partnerships for the future. (4) Exploring relevant technologies and networks for authoring and communicating the teacher's stories. (5) Enlisting the participation of potential user's of the teacher's stories in defining the products. (6) *Actually producing and delivering many educationally useful teacher's stories.* (7) Reporting the pilot study results with critical evaluation.

As described and illustrated below, (1) We have made technical progress by (1a) assembling our electronic publishing stations; (1b) designing electronic publications based on space science; (1c) developing distribution approaches for electronic products; (2) We have made progress addressing critical issues by (2a) developing policies and procedures for securing intellectual property rights; (2b) assembling a focus group of teachers to test our ideas and assure the quality of our products; (3) We are actually producing some useful materials, including (3a) the TOPS report; (3b) three electronic "PictureBooks"; (3c) one "ElectronicArticle"; (3d) three "ElectronicReports" in progress, (3e) ten "PrinterPosters", (3f) the "FaxForum" with an initial complement of printed materials; and (4) We have coordinated with planetary scientists and astronomers both at the technical and policy level to

assure the efficiency and ultimate utility of these efforts to derive educational benefits from the space science and exploration program as a whole.

1. TECHNICAL PROGRESS

Electronic publishing is important for educational products based on space science and exploration because the immediacy of electronic products can capture the excitement of discovery, such products are modular and can be incorporated into larger learning units, and the incremental cost per copy is negligible. Further, electronic products take advantage of the rapidly increasing installed base of suitable equipment—computers and fax machines—in schools and homes. A major thrust of our program is to master electronic publishing for the purposes of education based on the space science and exploration programs.

1.A ELECTRONIC PUBLISHING STATION

During the current reporting period, we have strengthened our computer setup, and we now have a significant multi-media authoring capability. We are able to capture sounds, video, still images (from data files, slides, and hard-copy), and text, and we are able to assemble these materials into educational products in the form of software, printed copy, and on-demand fax documents. Some of the products in section 3 illustrate the existing capabilities. We are now expanding the input modes to include still-frame and video camera (for people-based material), and the output modes to include video tape and cd-rom.

1.B ELECTRONIC PUBLICATION DESIGN

We have designed three electronic products based on space science and exploration: "PictureBooks", "ElectronicArticles", and "ElectronicReports". Our design activity consisted of determining the functional requirements on these products, designing their appearance and feel, writing the appropriate software or computer structure, and developing the methods and procedures to go from the basis material to the finished electronic product. Our accomplishments are illustrated by the examples discussed in section 3.

In general terms, our design emphasizes exploration by the student in original materials based on research. For example, the student is

presented images returned by the *Magellan* spacecraft to browse, and where interest strikes, to pursue to deeper levels, first to a glossary of technical words and beyond that to tutorials and exercises teaching fundamental concepts. Such user-driven exploration is well suited to "hyper" computing, and we have selected the Macintosh based HyperCard application as our initial platform. In the near future, we will have cross-platform products.

1.c Distribution Approaches

Our initial distribution mode has been floppy disk, but we have made significant progress towards other less costly distribution modes for our electronic products. We are now activating a computer bulletin board that can be called by teachers in our focus group to download our products. We have made our initial products available to commercial on-line services for distribution to the public. We are exploring cd-rom authoring as a way to collect and distribute electronic publications in bulk. We have discussed possible commercial distribution approaches with the Discovery Channel and the Apple Computer Corp. (Of course, no compensation to the grant-related parties is envisioned.)

2. Critical Issues

This grant supports a research project rather than an operational mission in education. Our emphasis is on discovering frameworks, methods, procedures, etc. that we believe are elements in overall educational solutions. Our ultimate role is to share and communicate our results and experiences in the expectations that our successes will inspire serious follow-on programs, and that our errors will not need to be repeated. In this spirit, we are addressing a variety of issues that bear on research-based education generally. In the current reporting period we worked on two issues: intellectual property rights and teacher feedback.

2.a Intellectual Property Rights

The basic material for educational products based on space program results consists of images and ideas created by others. When this material is incorporated into the new educational products, the right to do so must be secured.

We can distinguish three cases: NASA-generated materials (no problem), contractor-generated non-copyrighted materials (rights must be secured from owner or contracting officer, as appropriate), and original copyrighted material (rights must be secured from owner according to owner's conditions.

Our efforts have focussed on establishing definite procedures at ST ScI to determine and secure permission for the rights to use basic materials with each of these origins. We are now testing these procedures on particular cases falling into each of the three property rights categories.

2.B Quality Assurance

We have asked a small group of interested teachers to interact with us and provide us feedback on the utility of our products. The current focus group consists of:

Thomas A. Allen	Teacher	Auburn Academy	Auburn, WA
L. Blanchard Byrne	Teacher	Klemme/Belmond Junior High	Klemme, IA
Willard Lester	Teacher	Martin County High School	Steward, FL
Edith B. Merritt	Teacher	Vernel Elementary School	Tuscaloosa, AL
Richard Smith	Dept. Chair	Cabrillo Middle School	Ventura, CA
Jim Zimmerman	Teacher	Thomas Paine School	Urbana, IL
Holly Huitgren	Principal	Nederland Elementary School	Nederland, CO
Jane Moberg	Teacher	George Fox Middle School	Pasadena, MD
Fred Donelson	Teacher	Gahanna Lincoln High School	Gahanna, OH
James G. Hill	Obs. Director	French Camp Academy	French Camp, MS
M. Colleen Kozumplik	Dept. Chair	Loretto High School	Sacramento, CA
Ralph T. Pillsbury	Teacher	Port St. Lucie High School	Port St. Lucie, FL
Sandra L. Lester	Teacher	Dan McCarty Middle School	Fort Pierce, FL
Bonnie L. Bracey	Teacher	Ashlawn Elementary School	Arlington, VA
Karen Cowan	Teacher	Mendenhall Middle School	Livermore, CA
Rick Farrar	Teacher	Northern High School	Accident, MD

3. Products

During the reporting period we have produced a variety of materials that are either supportive or illustrative of our educational objectives.

3.A The TOPS report

This widely-admired report of the TOPS science working group describes a NASA plan to discover and study other planetary systems.

Figure 1 is the cover of the TOPS report. This is a subject with established public appeal, and one objective of the *Exploration in Education* program is to assure the educational benefits of the TOPS program. Indeed, the TOPS report itself recommends

> coupling of the TOPS Program with education and the public. In the last 30 years, NASA's planetary program, through its dramatic visits to the planets of our solar system, has forged a process that has transformed the excitement of modern-day exploration. Its success has been due in large part to the solidity and resilience of the program's framework. The astronomers and planetary scientists writing this report wish to continue this tradition of excellence by maximizing the public's opportunity to participate in the search for planets around other stars. Our search for other planets is, after all, a Nation's quest. The great public curiosity about the existence of extrasolar planets should thus be encouraged by the TOPS research program. Whereas *Mariner, Pioneer,* and *Voyager* returned a deluge of magnificent pictures, the special nature of the TOPS investigations will benefit from a concerted educational program to enhance the public's understanding of the research and its results.

We have begun the TOPS educational program with the report itself, which we plan to distribute soon as an ElectronicBook.

3.B Electronic PictureBooks

We have invented the PictureBook as the electronic equivalent of a slide set with tutorial and captions, of which there are many wonderful sets based on space science and exploration. We have produced three thus far: *Magellan at Venus, HST's Greatest Hits, and Terrestrial Impact Craters.* We have many others now in process. Figures 2-7 illustrate the three existing PictureBooks.

3.C Electronic Articles

We have chosen this name for electronic publications based on small written articles illustrated by figures and possibly video or audio clips. We have used a design different from the PictureBook design to

better accommodate the dominance of text over graphics. We have produced one electronic article based on the spin-cast 6.5 meter mirror recently made at the University of Arizona. This Electronic Article, blurbed in Figure 8, includes a desktop video clip of the melting mirror glass.

3.D Electronic Reports

We are well underway with three electronic books, which will have design features similar to the Electronic Articles. The three Electronic Report in progress are *TOPS, A Strategy for Recovery, and Spaceguard Survey.* The blurbs are Figures 9-11.

3.E Printer Posters

We have created a concept for posters based on mosaics of normal letter-sized paper. Students can readily assemble these posters for the walls of their classrooms or their homes. The benefits of this sort of poster: easy copying (Xerox), possible electronic distribution (fax machine), and simple reproduction and distribution as hardcopy (gummed pad).

We have created 10 such posters, which are illlustrated in Figure 12-22 at 1/4-1/3 normal size.

3.F FaxForum

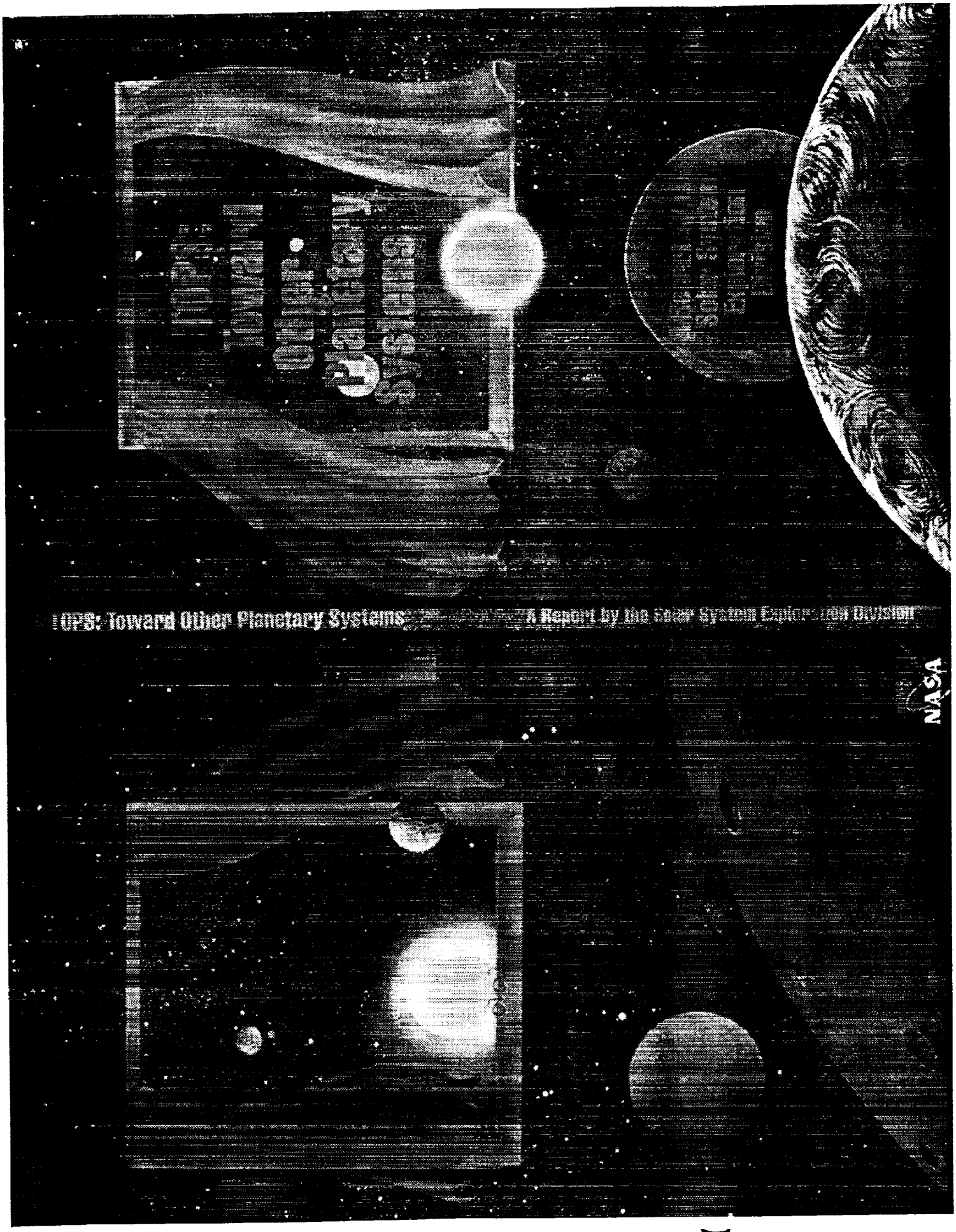
We have activated an on-demand fax-based distribution system for documentation both about and for *An Exploration in Education.* The benefit of this mode of communication is that interested parties can call in on their schedule with a touch-tone phone and request document (including indexes of documents), which are then transmitted to their fax machine.

Figure 23 shows the current contents of FaxForum related to education.

4. Community Coordination

A very important aspect of our work is communicating an orientation toward education to our scientific colleagues, and developing channels through which they can participate and develop the educational potential of their own work. To this end, we have attended—

usually by invitation—several meeting to describe and discuss the objectives of *An Exploration in Education*, including: Solar System Exploration Subcommittee (Washington; La Jolla), Astronomical Society of the Pacific (Madison, WI; San Francisco), Division for Planetary Sciences (Munich). At these meetings, in both formal presentations and informal discussion, we have made important contacts regarding both the directions of our research and ideas for future educational content and concepts.

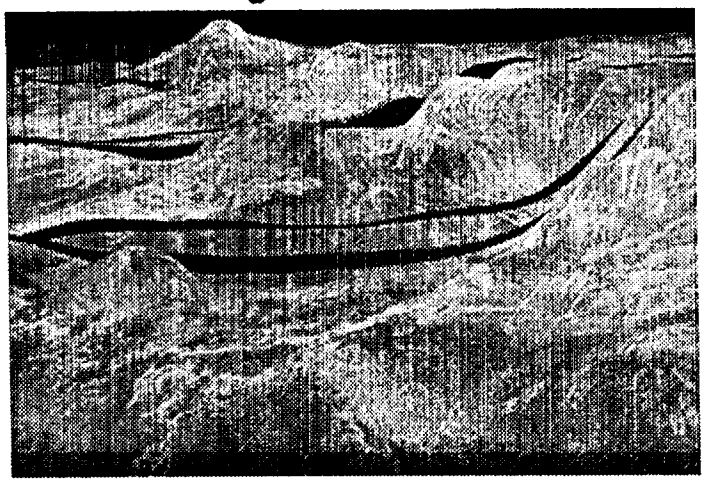


ORIGINAL PAGE IS
OF POOR QUALITY

Figure 1

Magellan at Venus

Magellan at Venus



Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109

Click anywhere to continue.

Magellan at Venus

Magellan at Venus

Index

Click a name in the numbered list to go straight to that picture

1 Trough Feature
2 Wind Streaks
3 Gridded Plains
4 Niobe and Lavinia Planitia
5 Western Claritha Tessera
6 Soviet Venera (Beheptu) 8
7 "Pancake" Volcanic Dome
8 Impact Crater Aurelia
9 Ridge Belts in Lavinia
10 Sacajawea Patera Volcano
11 Dome in Freyja Montes
12 Lal'ibela Plateau
13 Cleopatra Impact Crater
14 Maxwell Montes
15 Lava-flooded Crater
16 Sinuous Volcanic Channel
17 Dark Halo Impact Crater
18 Volcano Sif Mons
19 Mosaic of Impact Craters
20 Danu Montes

Magellan at Venus

Tutorial

Magellan is a NASA spacecraft mission to map the surface of Venus with imaging radar. The basic scientific instrument is a synthetic aperture radar, or SAR, which can look through the thick clouds perpetually shielding the surface of Venus. Magellan is in orbit around Venus which completes one turn around its axis in 243 Earth days. That period of time, one Venus rotation, is the length of Magellan's primary mission. During that time Magellan will map about 80% of the Venus surface. Subsequent missions of equal duration will provide complete mapping of the planet. Magellan was launched May 4, 1989, aboard the space shuttle Atlantis and went into orbit around Venus August 10, 1990. The spacecraft completes one orbit every 3 hours and 15 minutes, passing as close to the planet as 294 km and as far away from Venus as 8,472 km. The smallest visible objects measure approximately 120 meters.

Magellan at Venus

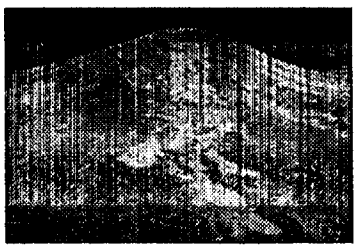
7. "Pancake" Volcanic Dome
7 of 20

Magellan at Venus

7. "Pancake" Volcanic Dome
25 km diameter, 30 S, 11.8 E

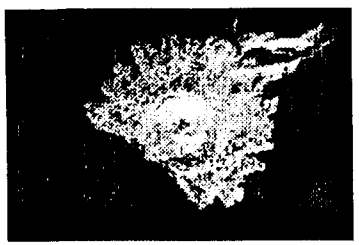
This image of the eastern edge of Alpha Regio was acquired November 7, 1990.
It shows seven circular domical hills averaging 25 km in diameter with maximum heights of 750 meters. These features can be interpreted viscous or thick eruptions of lava coming from a vent on the relatively level ground allowing the lava to flow in an even lateral pattern. The concentric and radial fracture patterns on their surface suggests if they are extrusive that a chilled outer layer formed, then further intrusion in the interior stretched the surface. The domes may be analogous to volcanic domes on Earth. An alternative interpretation is that domes are the result of

Magellan at Venus



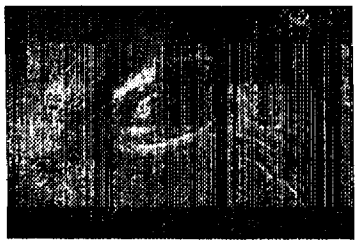
18. Volcano Sif Mons
18 of 20

Magellan at Venus



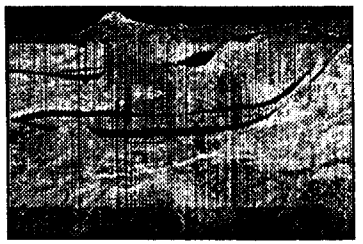
8. Impact Crater Aurelia
8 of 20

Magellan at Venus



10. Sacajawea Patera Volcano
10 of 20

Magellan at Venus



20. Danu Montes
20 of 20

Figure 2

ExInEd exploration in education

PictureBook

Magellan at Venus

Magellan, a NASA spacecraft sent to map the surface of Venus with imaging radar, was launched May 4, 1989 aboard the space shuttle Atlantis, and began radar operations for its mapping mission at Venus on September 15, 1990. The basic scientific instrument used on Magellan was a synthetic aperture radar, or SAR, able to look through the perpetually thick clouds of Venus to the planet's surface, which prior to Magellan had been virtually "unseeable" in any detail. Magellan made surface objects as small as 120 meters (400 ft) visible, thus providing valuable new insight into the geological history of the planet.

The "Magellan at Venus" PictureBook, created from an existing slide set distributed by the Jet Propulsion Laboratory in Pasadena, California, contains a selection of 20 of some of the most intriguing images and image mosaics of the surface of Venus, including views of mountains and plains, volcanoes and impact craters. The captions accompanying the pictures provide information about these surface features, including their location in latitude and longitude, a general description, and "guesses" as to what the features might represent in geological terms. The text also provides information about the images themselves, including the date the image was acquired, and the image resolution.

The PictureBook is built on a Hypercard stack and is designed to run on a Macintosh computer with HyperCard 2.1 and QuickTime 1.5.

This PictureBook is one of a series being produced by the Exploration in Education (ExInEd) program at the Special Studies Office of the Space Telescope Science Institute. The purpose of the ExInEd program is to discover new tools and approaches to relate space science and exploration to basic teaching and learning, and it involves searching for new ways to assemble and distribute the results of research, particularly images. Currently available by contacting the producers directly, the Electronic Picturebooks are eventually intended for distribution worldwide over computer networks from bulletin boards and on-line services, and by inclusion on magnetic or optical disks.

For more information on the ExInEd program, or to provide comments or suggestions on the Electronic Picturebook concept, please write: Dr. Robert A. Brown, Special Studies Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, or FAX your comments to (410) 516-7450.

For more information about the Magellan project, please write: Public Information Office, Jet Propulsion Laboratory, California Institute of Technology, National Aeronautics and Space Administration, Pasadena, California 91109, or call (818) 354-5011.

Figure 3

HST Greatest Hits

HST Greatest Hits

Pre-Release Version, November 17, 1992.

Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218

Click anywhere to continue.

HST Greatest Hits

HST Greatest Hits

Index

Click a name in the numbered list to go straight to that picture

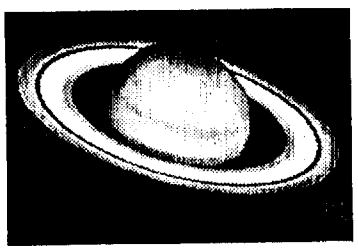
1 Saturn
2 Storm on Saturn
3 Pluto & Charon Double Planet
4 Orion Star-Forming Region
5 R Aquarii Symbiotic Star
6 True Color Jupiter
7 Mars, 3-Color Composite
8 Supernova Ring 1987A
9 Eta Carinae
10 Einstein Cross
11 47 Tucanae Globular Cluster
12 M15 Globular Cluster
13 M14 Globular Cluster
14 Beta Pictoris Spectrum
15 M87 Jet
16 NGC 1275
17 Gravitational Lens
18 Lyman Alpha Forest
19 M87
20 Nebula N66 in LMC
21 ARP 220
22 M51 "X" Black Hole
23 Medium Deep Survey
24 Cepheid Variable Stars
25 NGC 4261

HST Greatest Hits

Tutorial 1 of 9

When Lyman Spitzer first proposed a great, earth-orbiting telescope in 1946, the nuclear energy source of stars had been known for just six years. Knowledge of galaxies beyond our own and the understanding that our universe is expanding were only about twenty years of age in the human consciousness. The planet Pluto was seventeen. Quasars, black holes, gravitational lenses, and detection of the Big Bang were still in the future—together with much of what constitutes our current understanding of the solar system and the cosmos beyond it. In 1990, forty-four years after it was first conceived, the earth-orbiting Hubble Space Telescope (HST) became a reality....

HST Greatest Hits



1. Saturn
1 of 25

HST Greatest Hits

1. Saturn

This color image of Saturn was taken with the HST's Wide Field and Planetary Camera (WFPC) in the wide field mode at 8:25 A.M. EDT, August 26, 1990, when the planet was at a distance of 1.39 billion km from Earth.

The color in the image was reconstructed by combining three different pictures, taken in blue, green and red light (4390, 5470 and 7180 Angstroms).

Image reconstruction techniques have been applied to yield greater spatial detail in the planet's ring system and cloud belts than can be achieved with groundbased telescopes. Image resolution is 670 km per picture element (pixel). Saturn appears much as one would see it if it were only twice as far away as the Moon.

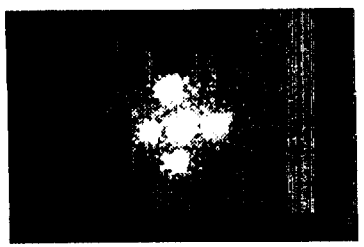
HST Greatest Hits

15. M87 Jet
15 of 25

HST Greatest Hits

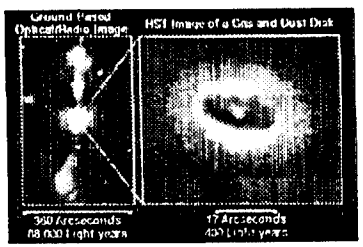
8. Supernova Ring 1987A
8 of 25

HST Greatest Hits



10. Einstein Cross
10 of 25

HST Greatest Hits



25. NGC 4261
25 of 25

ExInEd
exploration in education

PictureBook

HST's Greatest Hits

The Edwin P. Hubble Space Telescope (HST) was launched and deployed in low Earth orbit (368 miles or 593 kilometers above the Earth) on April 24, 1990. A 94 1/2 inch (2.4 meter) reflecting telescope, the HST is designed to remain in operation in space for 15 years. It is the largest, most complex, and most sensitive civilian space observatory deployed by the U.S. National Aeronautics and Space Administration (NASA), and is in the process of undertaking, jointly with the European Space Agency (ESA), an international program of scientific exploration of the cosmos.

The "HST's Greatest Hits" PictureBook presents some of the most spectacular and informative images taken with the scientific instruments of the HST during its first year of operation. Created from an existing slide set distributed by the Space Telescope Science Institute in Baltimore, Maryland, the PictureBook contains a selection of 24 images and highlights new theories about phenomena such as gravitational lenses and black holes now being developed as a result of these HST images. The captions accompanying the pictures provide information about the visual data contained in the individual images, including a general description of the features shown, and interpretations by the research astronomers involved. The text also provides information about the images themselves, including the date the image was acquired, and the image resolution. The PictureBook also contains a glossary of terms.

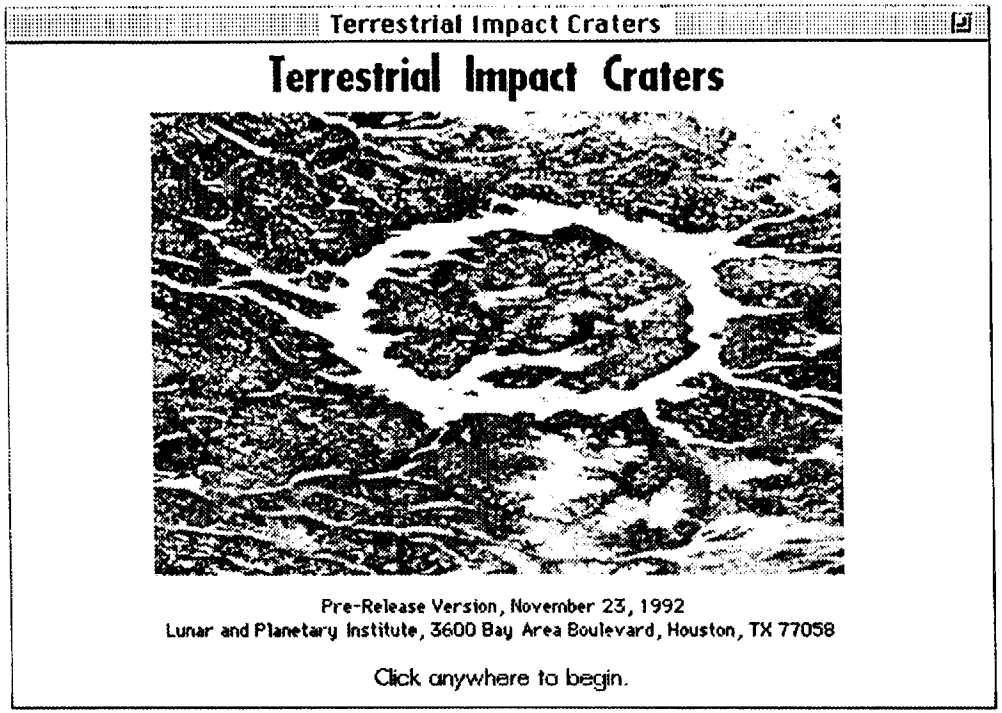
The PictureBook is built on a Hypercard stack and is designed to run on a Macintosh computer with Hypercard 2.1 and QuickTime 1.5.

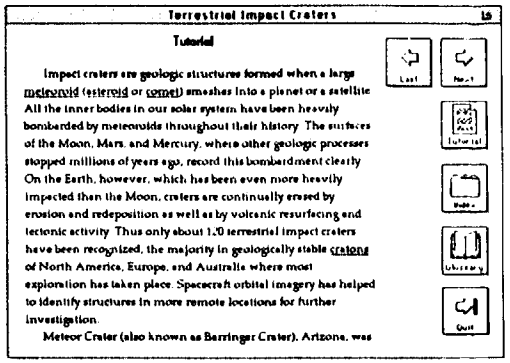
This PictureBook is one of a series being produced by the Exploration in Education (ExInEd) program at the Special Studies Office of the Space Telescope Science Institute. The purpose of the ExInEd program is to discover new tools and approaches to relate space science and exploration to basic teaching and learning, and it involves searching for new ways to assemble and distribute the results of research, particularly images. Currently available by contacting the producers directly, the Electronic Picturebooks are eventually intended for distribution worldwide over computer networks from bulletin boards and on-line services, and by inclusion on magnetic or optical disks.

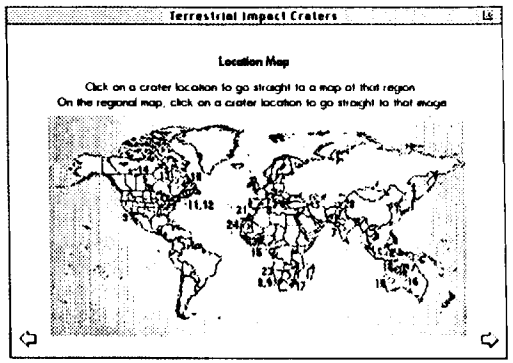
For more information on the ExInEd program, or to provide comments or suggestions on the Electronic Picturebook concept, please write: Dr. Robert A. Brown, Special Studies Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, or FAX your comments to (410) 516-7450.

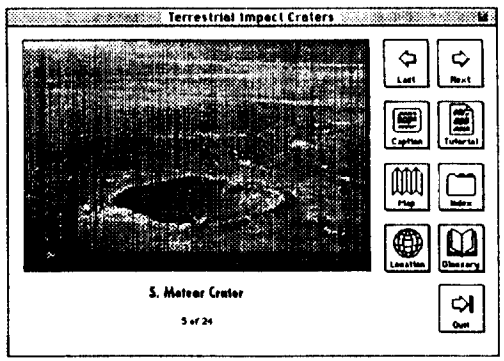
For more information about the Hubble Space Telescope, please write: Educational and Public Affairs Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218 or call (410) 338-4562.

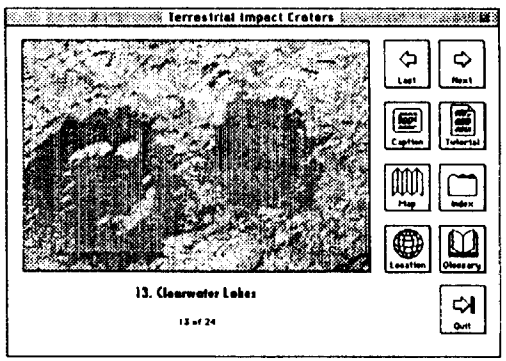
Figure 5

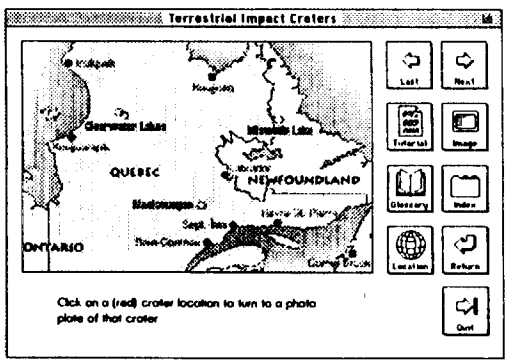


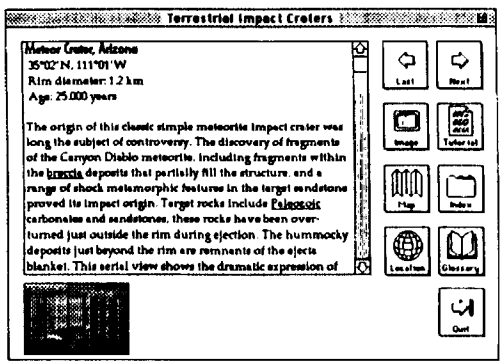


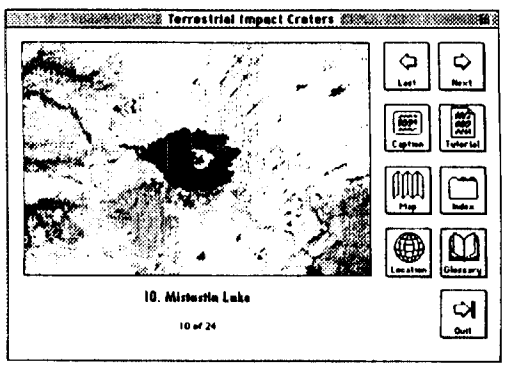












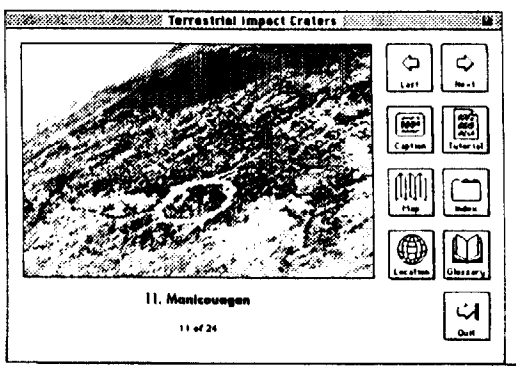


Figure 6

ExInEd
exploration in education

PictureBook

Terrestrial Impact Craters

Impact craters are craters formed when meteorites strike the surface of a planet. They are found on all of the terrestrial planets, on Earth's Moon, and on many of the satellites of the outer planets. Because impact has played a fundamental role in shaping the Earth's surface, studying these craters can help us understand the natural forces that drive our planet's evolution.

The "Terrestrial Impact Craters" PictureBook presents 16 orbital and aerial photographic views of proven or suspected impact structures on Earth. Although there are likely hundreds of impact craters on Earth, they are not easily recognized because of the intense weathering and erosion that continually wear away Earth's surface: mountain building, plate tectonics, weathering and erosion. The pictures selected therefore represent a compromise between those with the best surface expression and those that represent a diversity of age, size and appearance. The PictureBook also contains several examples of impact structures on Earth's planetary neighbors. These relatively well-preserved extraterrestrial craters provide an important reference to understanding the more eroded impact features on Earth.

The "Terrestrial Impact Craters" PictureBook, created from an existing slide set distributed by the Lunar & Planetary Institute in Houston, Texas, contains a selection of 25 images. The captions accompanying the pictures provide information about the individual impact structures, including their location in latitude and longitude, a general description, and explanations of what the features mean in geological terms. Locations of all the 25 structures are provided on maps. A glossary of terms is also included.

The PictureBook is built on a Hypercard stack and is designed to run on a Macintosh computer with HyperCard 2.1 and QuickTime 1.5.

This PictureBook is one of a series being produced by the Exploration in Education (ExInEd) program at the Special Studies Office of the Space Telescope Science Institute. The purpose of the ExInEd program is to discover new tools and approaches to relate space science and exploration to basic teaching and learning, and it involves searching for new ways to assemble and distribute the results of research, particularly images. Currently available by contacting the producers directly, the Electronic Picturebooks are eventually intended for distribution worldwide over computer networks from bulletin boards and on-line services, and by inclusion on magnetic or optical disks.

For more information on the ExInEd program, or to provide comments or suggestions on the Electronic Picturebook concept, please write: Dr. Robert A. Brown, Special Studies Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, or FAX your comments to (410) 516-7450.

Figure 7

ExInEd exploration in education **Electronic Article**

6.5 Meter Mirror Casting

Science is often driven by technology, and inventing new technology is clearly the business of the Steward Observatory Mirror Laboratory in Tucson, Arizona. Its latest achievement is the successful casting of a 6.5 meter diameter borosilicate honeycomb mirror. Developing the tools and techniques necessary for this achievement have been the goals of a 10-year project aimed at eventually producing affordable, high-quality 8 meter telescope mirrors.

The "6.5 Meter Mirror Casting" Electronic Article, created from a paper written by J.M. Hill and J.R.P. Angel of Steward Observatory describes the process of casting this remarkable 6.5 meter mirror. It includes descriptions and photos of the project from the initial mold building in June 1991 to the final cooling process, which was completed a year later. A large part of the Article deals with the annealing process itself, which involved melting 10 tons of glass in a furnace and rotating it at a speed of 7.4 rpm for 70 hours at a peak temperature of 1180°C to form the desired parabolic mirror surface. This process was captured in time-lapsed photography and is included as a short video in the Article.

The mirror will be used in Steward Observatory's Multiple Mirror Telescope (MMT) conversion project which involves upgrading their existing MMT to a monolithic (single-mirror) 6.5 meter aperture telescope. This Electronic Article captures the inventors' excitement and is instructive of how technological invention can advance scientific discovery. It is a brief but fascinating look at science from a technology perspective.

"6.5 Meter Mirror Casting" is built on a Hypercard stack and is designed to run on a Macintosh computer with Hypercard 2.1 and QuickTime 1.5.

The Electronic Article is one of a series being produced by the Exploration in Education (ExInEd) program at the Special Studies Office of the Space Telescope Science Institute. The purpose of the ExInEd program is to discover new tools and approaches to relate space science and exploration to basic teaching and learning, and it involves searching for new ways to assemble and distribute the results of research, particularly images. Currently available by contacting the producers directly, the Electronic Articles are eventually intended for distribution worldwide over computer networks from bulletin boards and on-line services, and by inclusion on magnetic or optical disks.

For more information on the ExInEd program, or to provide comments or suggestions on the Electronic Article concept, please write: Dr. Robert A. Brown, Special Studies Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, or FAX your comments to (410) 516-7450.

For more information about the Steward Observatory Mirror Laboratory, please write: Steward Observatory, University of Arizona, Tucson, AZ 85721, or FAX your questions to (602) 621-1532.

Figure 8

ExInEd exploration in education

Electronic Report

TOPS

Curiosity about the origin and evolution of planets other than Earth is not limited to those in our solar system. Rather, as technologies improve and capabilities expand, interest in the astronomical community has moved to looking for planets around other stars. With this interest comes the prospect of discovering another or even many planets like Earth—ones that might, in the most exciting of possibilities, harbor intelligent life.

The National Aeronautics and Space Administration (NASA) is in the process of developing a program to explore just such possibilities. Named the "Towards Other Planetary Systems," or TOPS program, it is being established to fulfill two major science goals: to discover and study a significant number of fully formed planet systems and then, as technologies advance, to investigate individual systems and their planets. The program will be implemented in three phases: a ground-based observational phase, a space-based observational phase, and a "new technology" phase, using whatever technologies can be developed to make it possible to observe individual planets and their systems directly.

The "TOPS" Electronic Report has been created from a landmark report of the Science Working Group of NASA's Solar System Exploration Division, which was assigned to develop a plan and to name the technologies needed to implement this program. A fascinating collection of historical information, technical description, and intellectual expectation, the Electronic Report captures the scientific excitement and philosophical tension of discovering and exploring new planets, and the possibility of encountering new forms of life.

The Electronic Report is built on a Hypercard stack and is designed to run on a Macintosh computer with Hypercard 2.1 and QuickTime 1.5.

This Electronic Report is one of a series being produced by the Exploration in Education (ExInEd) program at the Special Studies Office of the Space Telescope Science Institute. The purpose of the ExInEd program is to discover new tools and approaches to relate space science and exploration to basic teaching and learning, and it involves searching for new ways to assemble and distribute the results of research, particularly images. Currently available by contacting the producers directly, the Electronic Reports are eventually intended for distribution worldwide over computer networks from bulletin boards and on-line services, and by inclusion on magnetic or optical disks.

For more information on the ExInEd program, or to provide comments or suggestions on the electronic Electronic Report concept, please write: Dr. Robert A. Brown, Special Studies Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, or FAX your comments to (410) 516-7450.

For more information about the TOPS program, please write: NASA Headquarters, Code SLC, Two Independence Square, 300 E Street, S.W., Washington, D.C. 20546, ATTN: Dr. Jurgen H. Rahe or FAX your questions to that office at: (202) 358-3097.

Figure 9

ExInEd exploration in education **Electronic Report**

A Strategy for Recovery

The Hubble Space Telescope (HST) was launched on April 24, 1990. By June 1990, NASA had discovered a problem with the telescope's optics: spherical aberration of the primary mirror. Unsatisfied with a solution of simply redesigning all 2nd generation instruments, which would result in the telescope's capabilities being greatly lessened until the new instruments were put in place in 1997, NASA sought an innovative plan. In August 1990, NASA authorized the Space Telescope Science Institute to convene an HST Strategy Panel to search for additional or alternative solutions. This panel, led by Drs. Robert A. Brown and Holland C. Ford, invented an intriguing solution to the problem of spherical aberration, to be implemented during the first HST servicing mission in December 1993. The "fix," as it was called by the HST Strategy Panel and later adopted by NASA, is a "Corrective Optics Space Telescope Axial Replacement" or COSTAR, an instrument that will place corrective mirrors in front of the openings that admit light into three of HST's observing instruments, refocussing the light before it enters them. COSTAR will restore the optical performance of these instruments to a level sufficient to conduct most of their original science programs. One instrument, the Wide Field and Planetary Camera (WF/PC), cannot be corrected with the COSTAR, so will be completely replaced with a modified version of the instrument.

This Electronic Report, "A Strategy for Recovery," presents the history and plans for HST's recovery with COSTAR. Created from the full-length report of the HST Strategy Panel, it contains the original text and graphics, and includes as well a movie of the COSTAR's planned deployment and a full glossary of terms.

The Electronic Report is built on a Hypercard stack and is designed to run on a Macintosh computer with Hypercard 2.1 and QuickTime 1.5.

This Electronic Report is one of a series being produced by the Exploration in Education (ExInEd) program at the Special Studies Office of the Space Telescope Science Institute. The purpose of the ExInEd program is to discover new tools and approaches to relate space science and exploration to basic teaching and learning, and it involves searching for new ways to assemble and distribute the results of research, particularly images. Currently available by contacting the producers directly, the Electronic Reports are eventually intended for distribution worldwide over computer networks from bulletin boards and on-line services, and by inclusion on magnetic or optical disks.

For more information on the ExInEd program, or to provide comments or suggestions on the Electronic Picturebook concept, please write: Dr. Robert A. Brown, Special Studies Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, or FAX your comments to (410) 516-7450.

For more information about the Hubble Space Telescope or COSTAR, please write: Educational and Public Affairs Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218 or call (410) 338-4562.

Figure 10

ExInEd exploration in education **Electronic Report**

Spaceguard Survey

Should the Earth be struck by an asteroid or comet larger than 1 km in diameter, the consequences are potentially catastrophic and, in fact, could totally alter the Earth's climate. What are the risks of such an impact? Probably small, but the truth is, *we really don't know.*

In light of this uncertainty, the National Aeronautics and Space Administration (NASA) is considering a program to search for and analyze the orbits of Earth-crossing asteroids (ECAs), with the idea that the potentially dangerous objects could be destroyed or their orbits changed in time to cause them to "miss" Earth. Named "The Spaceguard Survey," the program would entail a systematic survey of all ECAs by monitoring a large volume of space around Earth and analyzing the orbits of frequently appearing objects, as well as those whose larger orbit makes them visible only every 5-10 years. NASA is considering this 25-year program as an international effort, involving a world-wide network of specialized ground-based telescopes. If the program were to begin now, utilizing smaller projects already in place, and were to expand to full capacity by the end of this century, the risk of a catastrophic impact could be reduced by more than 75% over the next 25 years.

This "Spaceguard Survey" Electronic Report was created from the formal report of the NASA International Near-Earth-Object Detection Workshop and it outlines and explains the plans and rationale for this comprehensive search. A tutorial on asteroids and comets, and a compendium of images, as well as a fascinating description of the proposed program, the Electronic Report is a fun and educational "read" for all ages.

The Electronic Report is built on a Hypercard stack and is designed to run on a Macintosh computer with Hypercard 2.1 and QuickTime 1.5.

This Electronic Report is one of a series being produced by the Exploration in Education (ExInEd) program at the Special Studies Office of the Space Telescope Science Institute. The purpose of the ExInEd program is to discover new tools and approaches to relate space science and exploration to basic teaching and learning, and it involves searching for new ways to assemble and distribute the results of research, particularly images. Currently available by contacting the producers directly, the Electronic Reports are eventually intended for distribution worldwide over computer networks from bulletin boards and on-line services, and by inclusion on magnetic or optical disks.

For more information on the ExInEd program, or to provide comments or suggestions on the electronic Electronic Report concept, please write: Dr. Robert A. Brown, Special Studies Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, or FAX your comments to (410) 516-7450.

For more information about The Spaceguard Survey program, please write:

Figure 11

ExInEd
exploration in education

PrinterPoster

Views of the Solar System

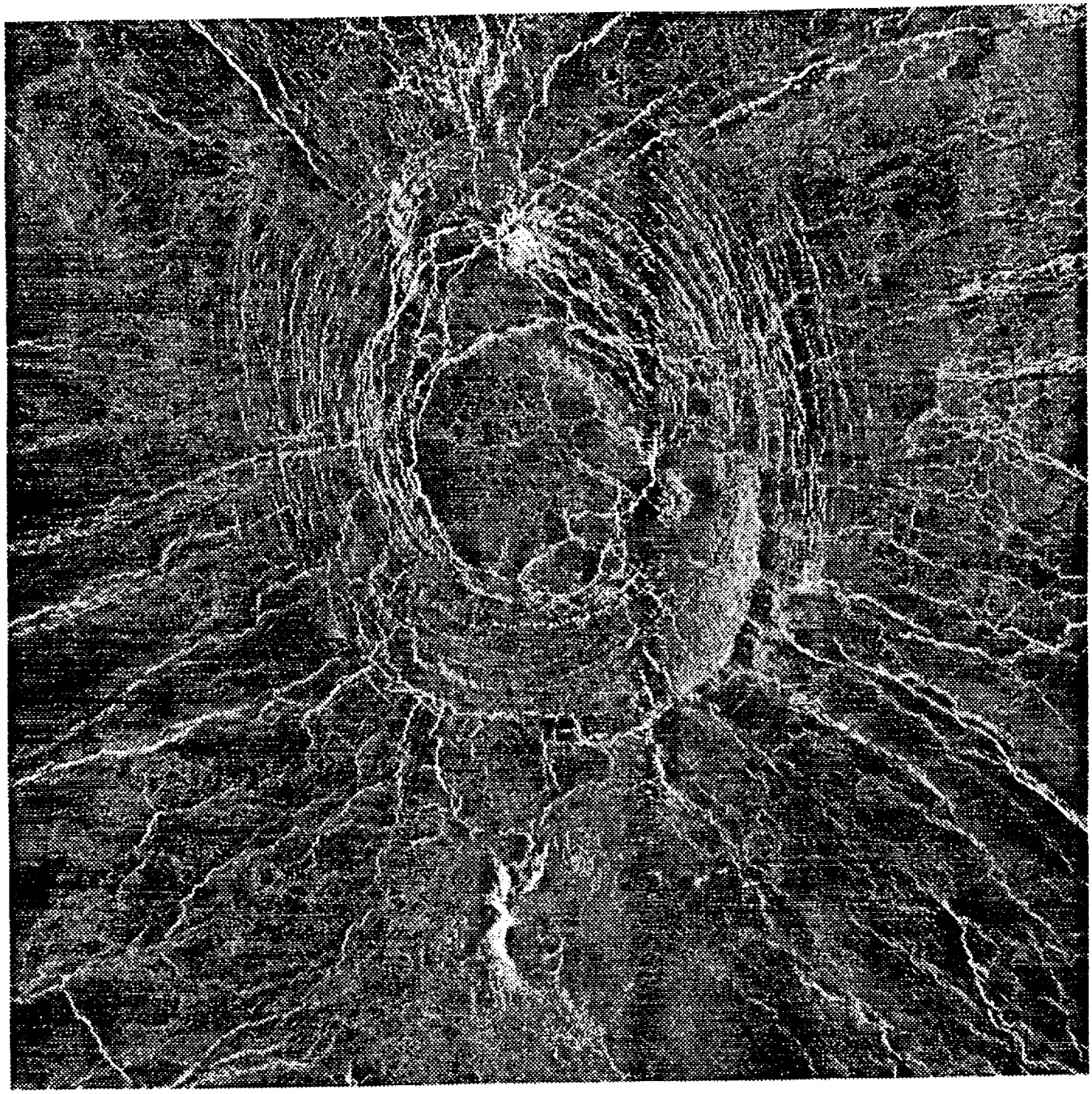
Our knowledge of the Solar System, trapped for ages within the vision-obscuring bounds of Earth's atmosphere, was freed in the 1960s when unmanned spacecraft, complete with cameras, probes, and other data sensors, were launched into space to explore our sister planets. Today, these worlds have become familiar to us and our understanding of their geology and history, though far from complete, is greatly expanded as a result of these journeys into space.

We have collected ten of the extraordinary images obtained by these unmanned machines into a set of PrinterPosters for fun at home and in the classroom. The poster set, available free-of charge in hard copy or on diskette, can be photocopied or printed out on a standard laser printer. Each poster is made up of a number of 8 1/2 x 11 sheets which you can tape or glue together into a wall-sized poster of one of the worlds of our Solar System. The "Views of the Solar System" set includes images of Saturn, Venus, Mars, Jupiter, Mercury, and Earth.

This PrinterPoster set is one of a series being produced by the Exploration in Education (ExInEd) program at the Special Studies Office of the Space Telescope Science Institute. The purpose of the ExInEd program is to discover new tools and approaches to relate space science and exploration to basic teaching and learning, and it involves searching for new ways to assemble and distribute the results of research, particularly images. Currently available by contacting the Special Studies Office directly, the PrinterPosters are eventually intended for distribution worldwide over computer networks from bulletin boards and on-line services, and by inclusion on magnetic or optical disks.

For more information on the ExInEd program or its products, or to provide comments or suggestions on the PrinterPoster concept, please write: Dr. Robert A. Brown, Special Studies Office, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, or FAX your comments to (410) 516-7450.

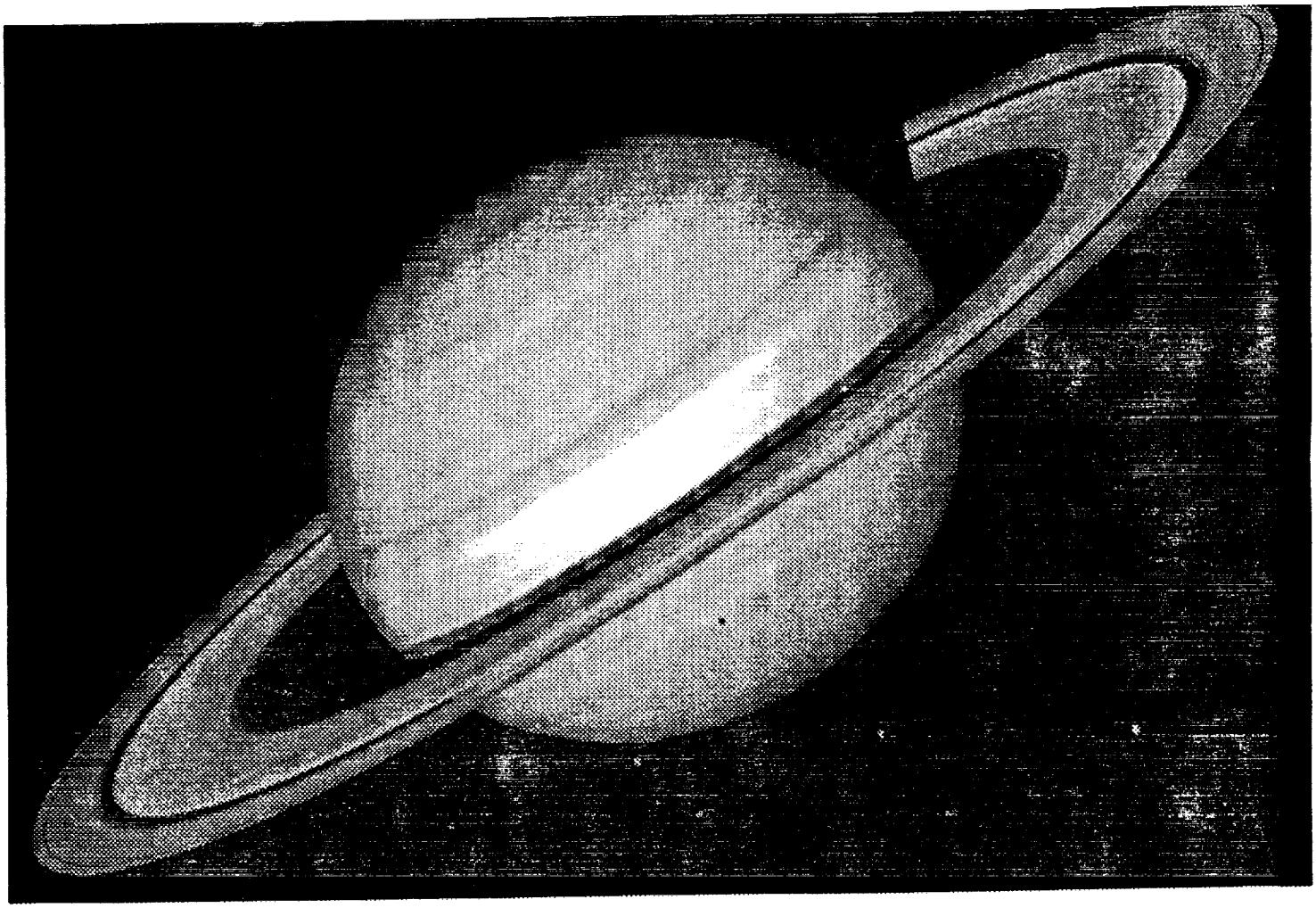
Figure 12



Venus

Magellan acquired this view of Venus during its first mapping journey around the planet in orbit during 1990 and 1991. This region, roughly 1000 km on a side, shows a gigantic volcanic structure known as a corona. Such features are thought to be the result of hot rising bodies of magma which reach the crust and cause it to partially melt and collapse, generating volcanic flows and fault patterns that radiate from the central structure.

Figure 13



Saturn

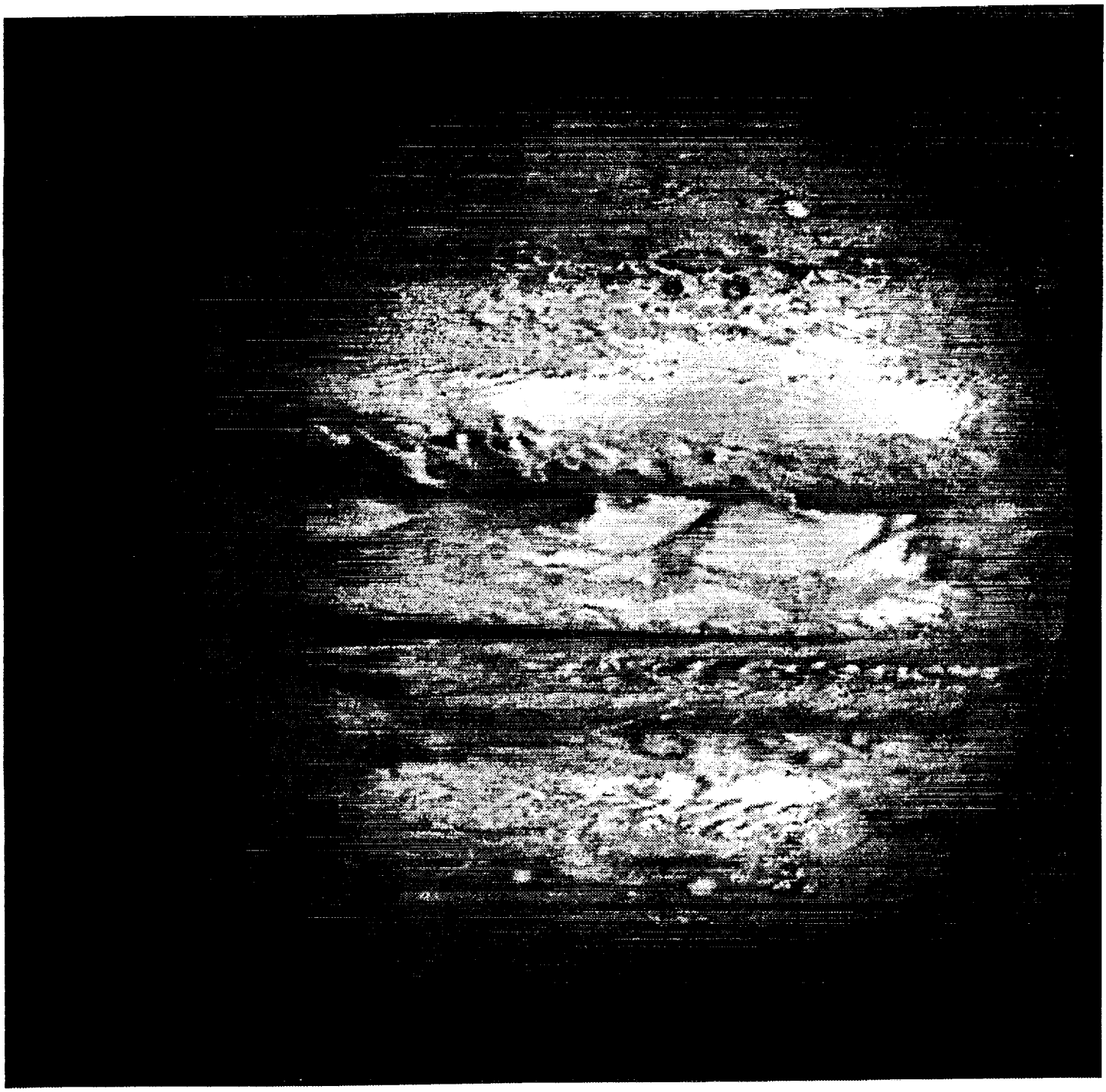
Voyager acquired this view of Saturn and three of its satellites while approaching the ringed planet. The disk of Saturn casts a shadow across the rings. The satellites Mimas, Enceladus, and Tethys seen in the lower right all orbit Saturn in the plane of its rings and its equator.

Frame 14

Ophir Chasma

This perspective view of the Ophir Chasma region of Mars was generated by a computer from a combination of Viking Orbiter images and a model of the surface topography. This is part of the enormous Valles Marineris canyon system in the central equatorial region. The region covered is about 200 km on a side. The depth of the canyon is about 6 km.

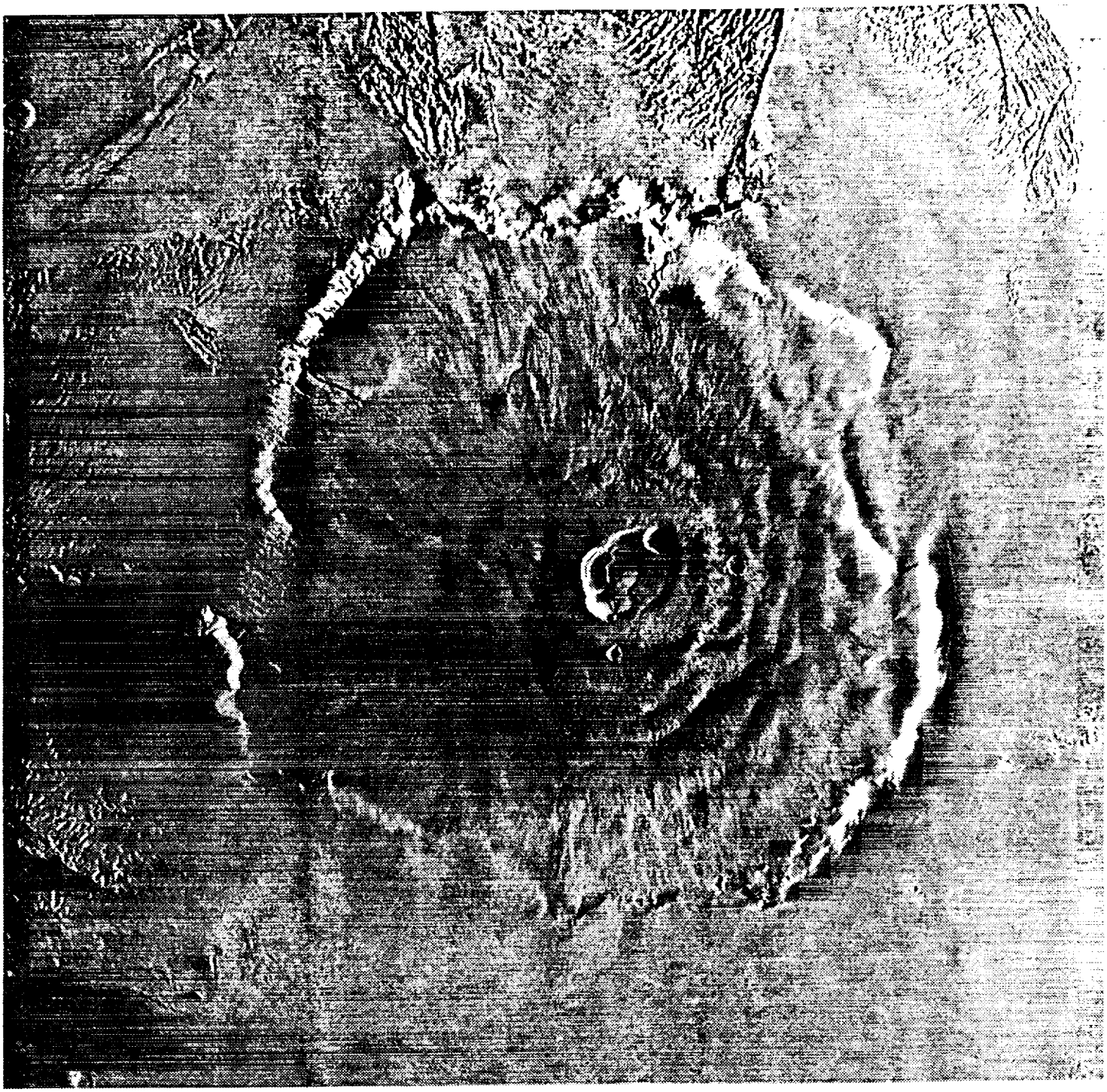
Figure 15



Jupiter

This Voyager image of Jupiter shows belts (dark) and zones (light) that move relative to one another in east and west directions with velocities of hundreds of meter a second.

Figure 16



Mars

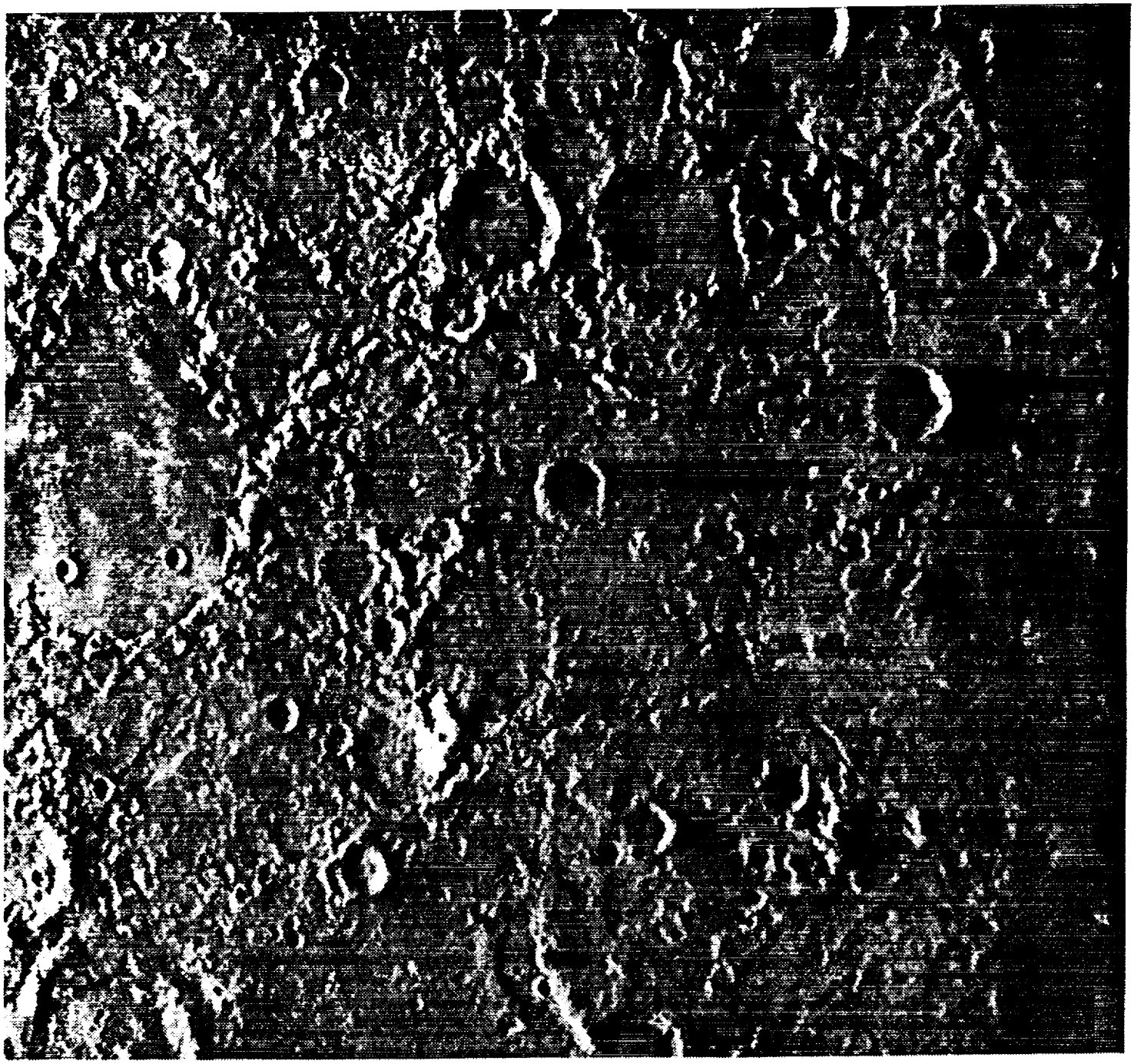
Mosaic of Viking Orbiter images of a large volcanic construct in Mars' north equatorial region. Olympus Mons is roughly the width of the state of Arizona at its base. It exceeds the altitude of Mt. Everest by about 10 miles.

Figure 17

Mars' South Pole

This Viking Orbiter mosaic shows the south polar cap of Mars near its final stages of retreat near the end of southern summer. The temperature of this cap is controlled by carbon dioxide ice keeping it at a temperature near 130 K throughout the martian year. The cap is approximately 500 km in diameter.

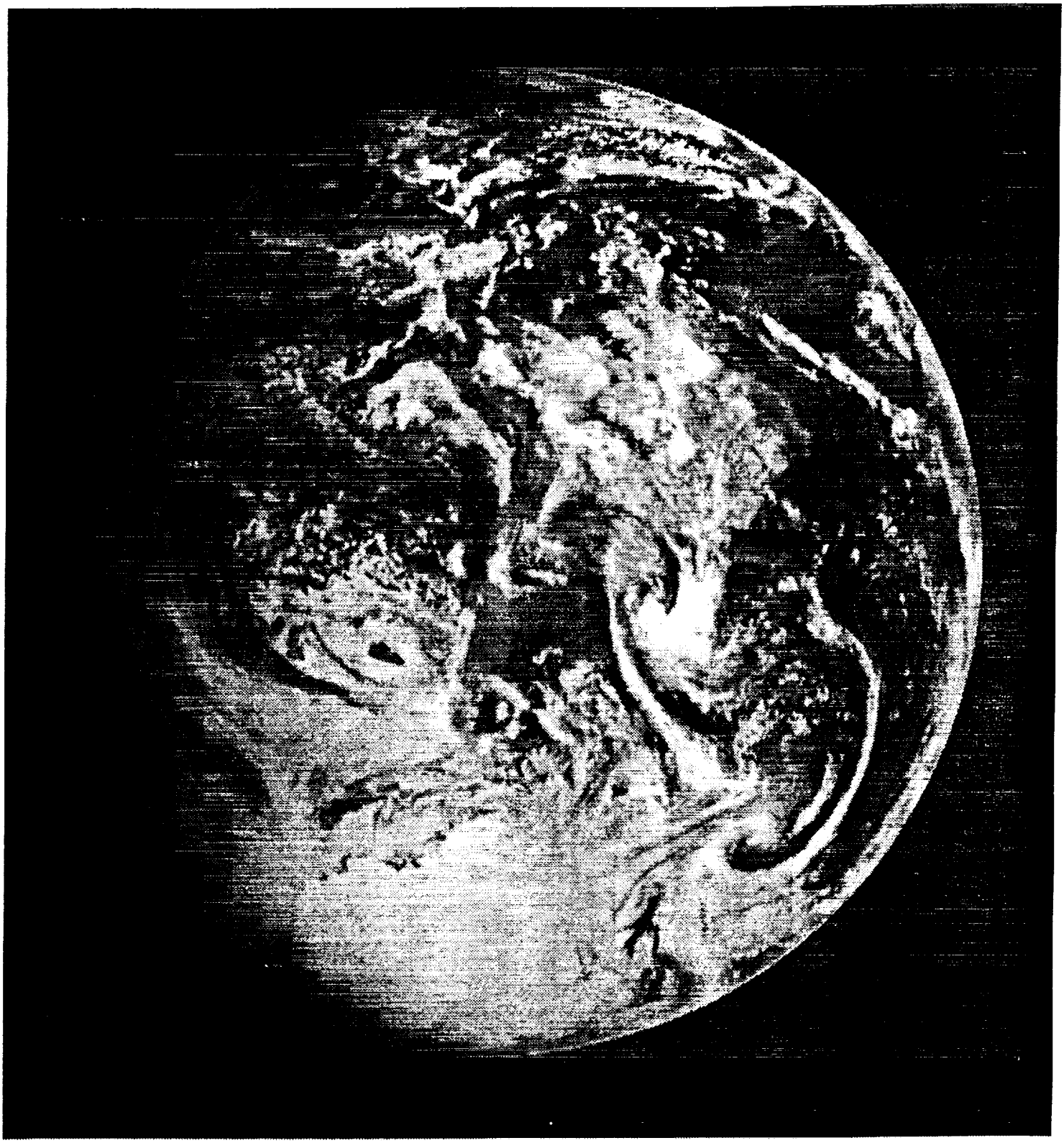
Figure 18



Mercury

This Mariner 10 image of Mercury shows a region of the planet termed "weird terrain." This region is at the antipodal point to the large Caloris Basin. Perhaps the shock wave of the impact that produced the Caloris Basin was focused in this region, jumbling the crust into a maze of complex blocks. The area shown is about 100 km on a side.

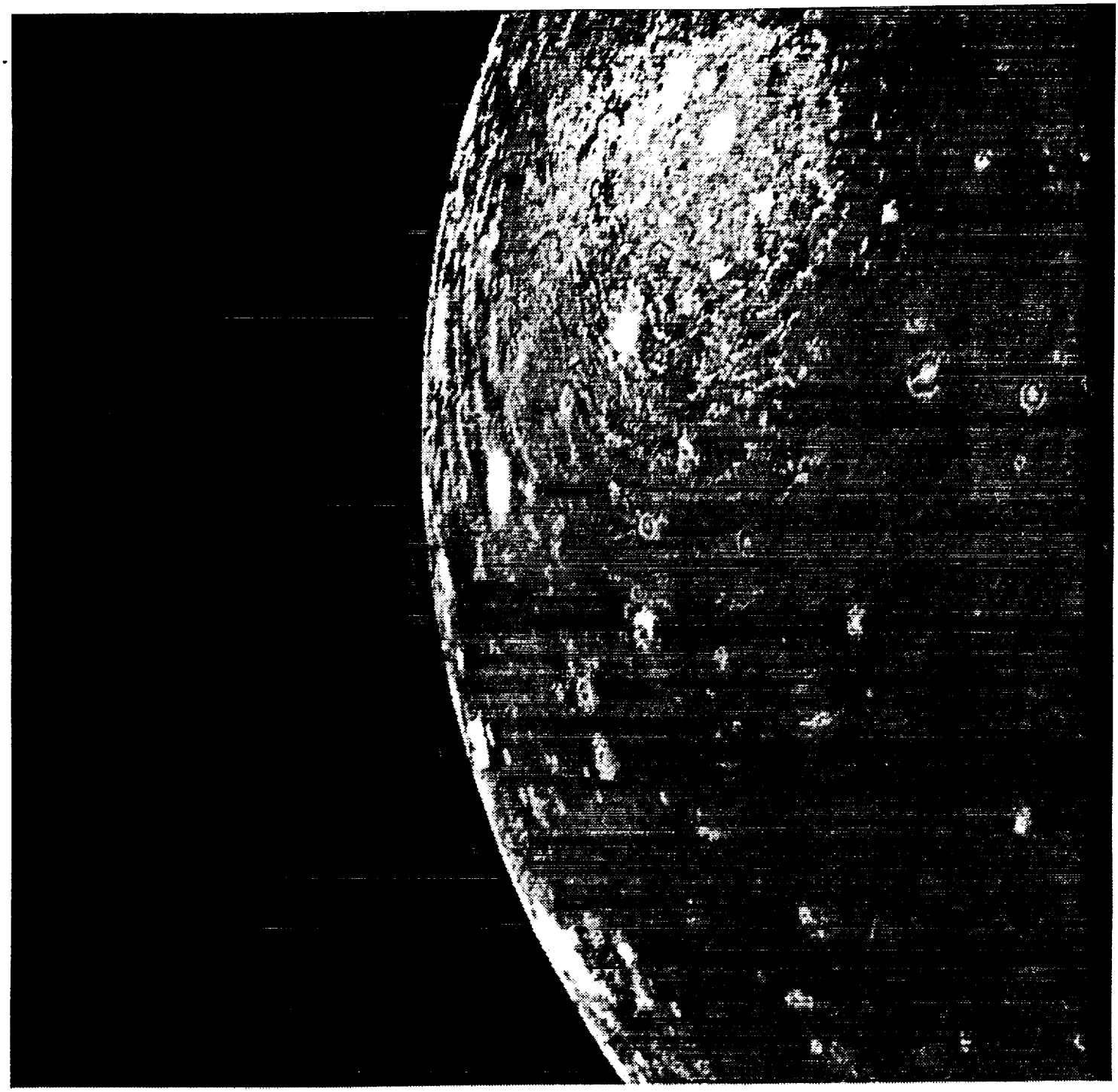
Figure 19



Earth

Galileo obtained this picture of the Earth on December 11, 1990, when the spacecraft was about 1.3 million miles away. South America is near the center, and the white, sunlit continent of Antarctica is below. Weather fronts are visible in the South Atlantic, lower right.

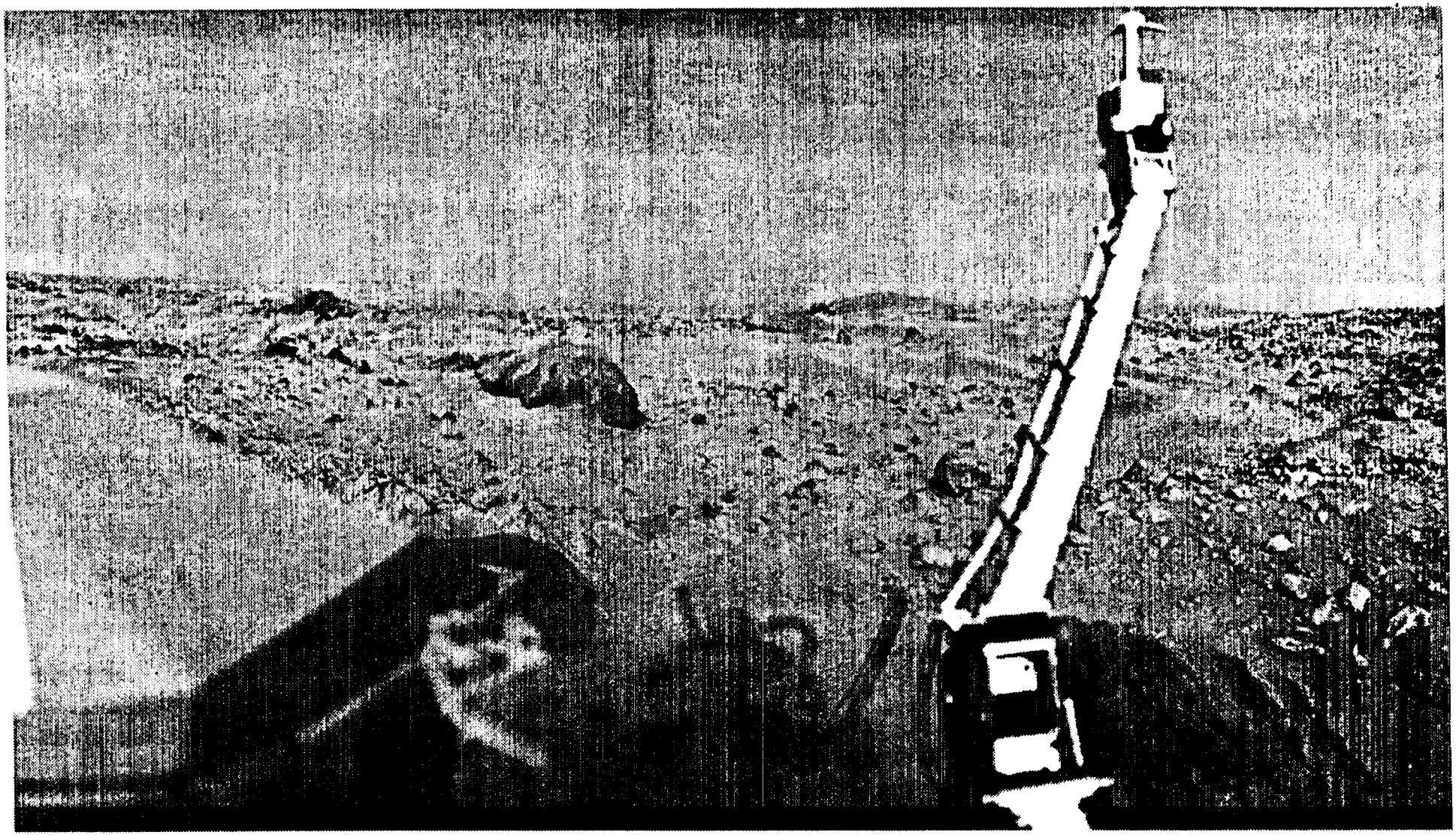
Figure 20



Callisto

This Voyager image of Callisto shows a global scale, ancient scar of an impact that occurred when the icy crust was soft and pliable. Enormous rings surrounding the central target zone record the crustal response as the enormous impact cavity collapsed.

Figure 21



"Big Joe"

On July 20th, 1976, the Viking 1 lander provided us with our first close-up views of the martian surface, a scene reminiscent of terrestrial deserts. "Big Joe", the large block in the near-field, is 2 meters across.

3000 An Exploration in Education

0 items/no list

3100 Educational Products Workshop

0 items/no list

We are striving in this section of the FaxForum to highlight new educational products that successfully connect science research with basic education. Our plan is to create and, as appropriate, to collect existing stand-alone elements that eventually can be pulled together into a larger, more complete unites which we will call "teacher's stories." Thus far we have developed two new products, PrinterPosters and Electronic PictureBooks, which we believe do an excellent job of conveying the results of research and which we have found can be distributed quickly by electronic means. We hope you will be encouraged to test out the products below by either distributing them to your students or using them directly in your classroom teaching. Product descriptions and ordering instructions for the electronic publications are available through the FaxForum. Any comments or suggestions you may have about these products are welcome.

3110 Posters

0 items/no list

3111 PrinterPosters

10 items 9/15/92

3111 Solar System Fax Posters

001 **Index**

301 **Jupiter** This Voyager image of Jupiter shows belts (dark) and zones (light) that move relative to one another in east and west directions with velocities of hundreds of meter a second. 9 pgs

302 **Mars** Mosaic of Viking Orbiter images of a large volcanic construct in Mars' north equatorial region. Olympus Mons is roughly the width of the state of Arizona at its base. It exceeds the altitude of Mt. Everest by about 10 miles. 9 pgs

303 **Venus** Magellan acquired this view of Venus during its first mapping journey around the planet in orbit during 1990 and 1991. This region, roughly 1000 km on a side, shows a gigantic volcanic structure known as a corona. Such features are thought to be the result of hot rising bodies of magma which reach the crust and cause it to partially melt and collapse, generating volcanic flows and fault patterns that radiate from the central structure. 9 pgs

304 **Earth** Galileo obtained this picture of the Earth on December 11, 1990, when the spacecraft was about 1.3 million miles away. South America is near the center, and the white, sunlit continent of Antarctica is below. Weather fronts are visible in the South Atlantic, lower right. 9 pgs

305 **Callisto** This Voyager image of Callisto shows a global scale, ancient scar of an impact that occurred when the icy crust was soft and pliable. Enormous rings surrounding the central target zone record the crustal response as the enormous impact cavity collapsed. 9 pgs

306 **Saturn** Voyager acquired this view of Saturn and three of its satellites while approaching the ringed planet. The disk of Saturn casts a shadow across the rings. The satellites Mimas, Enceladus, and Tethys seen in the lower right all orbit Saturn in the plane of its rings and its equator. 9 pgs

307 **Mercury** This Mariner 10 image of Mercury shows a region of the planet termed "weird terrain." This region is at the antipodal point to the large Caloris Basin. Perhaps the shock wave of the impact that produced the Caloris Basin was focused in this region, jumbling the crust into a maze of complex blocks. The area shown is about 100 km on a side. 9 pgs

308 **"Big Joe"** On July 20th, 1976, the Viking 1 lander provided us with our first close-up views of the martian surface, a scene reminiscent of terrestrial deserts. "Big Joe", the large block in the near-field, is 2 meters across. 9 pgs

309 **Mars' South Pole** This Viking Orbiter mosaic shows the south polar cap of Mars near its final stages of retreat near the end of southern summer. The temperature of this cap is controlled by carbon dioxide ice keeping it at a temperature near 130 K throughout the martian year. The cap is 9 pgs

Figure 23/1

approximately 500 km in diameter.

310 Ophir Chasma This perspective view of the Ophir Chasma region of Mars was generated by a computer from a combination of Viking Orbiter images and a model of the surface topography. This is part of the enormous Valles Marineris canyon system in the central equatorial region. The region covered is about 200 km on a side. The depth of the canyon is about 6 km. 9 pgs

3112 Mail-Order Posters 1 item 12/01/92

3120 Electronic Publishing

Electronic publishing promises to be an increasingly effective method of authoring and distributing educational results of scientific research. The distinctive benefits are (1) negligible recurring cost; (2) efficient dissemination via telecommunications; (3) new ways for users to interact with information. This location describes what we've done and how we've done it. Also, it provides bug reports and comments we have received. We invite anyone interested to download our test products from our bulletin board, 410-516-4880 (to be operational Dec. 1992).

3120 Electronic Publishing

001 Index

301 Overview of Current Projects 3 items 12/01/92

- 3121 Electronic PictureBooks 0 items/no list
- 3122 Electronic Articles 0 items/no list
- 3123 Electronic Reports 0 items/no list

3200 Literary Forums 0 items/no list

+ 3210 Interdisciplinary Learning 0 items/no list

3211 America's Valuation of Exploration 22 items 10/16/92

Americans typically link "exploration" (intellectual, geographic, scientific, etc.) with other inherently positive concepts, such as "freedom" and "opportunity". The documents in this location—which consist mainly of excerpts from articles and essays on the topic of exploration—seek to examine the important influence the concept has had on the shaping of America's history and current perspective. We hope that you will find these selections valuable in a variety of educational settings and subject areas, particularly to spark interdisciplinary discussions and conceptual thinking.

3211 America's Valuation of Exploration

Americans are unusual in their ongoing tendency to mythologize about exploration and to praise its linkage with the values of freedom and opportunity. The tendency shows up clearly in American language, cultural heroes, laws, and politics.

This section of the FaxForum is set up to engender discussion about the idea and value of exploration. The materials it contains offer information and insight into the American perspective on exploration by touching on its history and future in our society, and its perceived purpose and long-term effect. Documents numbered in the 300s are excerpts from popular writings which have been selected primarily on the basis of how well they convey this perspective. They focus loosely on exploration in science and space, the two investigative trends of perhaps the most urgent interest to Americans today. The first pieces (300-306) comment on the motivations of exploration and the effect these motivations have had on American character and personality. The next four pieces consider how and why the American government has historically taken an interest in and continues to fund exploration (307-310). Ideas on exploration from some recent U.S. presidential leaders are next (311-314), followed by two commentaries on the significance of exploration to education (315-316). The remaining thought pieces (317-321) present several opinions about the future directions, value, and impact of American exploring. We have indicated in this index what we think are appropriate grade levels and subjects for each document and are have included a keyword index (below). We hope that you will find the selections valuable in a variety of educational settings and subject areas, particularly to spark interdisciplinary discussions and conceptual thinking.

This section of the FaxForum also contains information on popular national educational projects developed around the theme of exploration. These documents are numbered beginning with 500. If you know of other proven projects that are concentrated on developing the theme of exploration for educational purposes and are

national in scope, please send us the information and we will post them in this section also.

In fact, any additions, comments, or suggestions you may have regarding any of these selections will be very much appreciated. Please send your thoughts to us via fax at (410) 516-7450 or e-mail to ishee@avion.stsci.edu.

Keyword Cross-reference (Numbers in parentheses are document numbers minus 300.)

304	**A COMPLEX FATE. Historian Perry Miller on the shaping of American character and personality.** From: *Nature's Nation* by Perry Miller (Cambridge: The Belknap Press, 1967) pp. 1-13. • *6-8, 9-12. English, History, Social Studies, Psychology*	3 pgs	character identity nature
305	**PIONEER HERO. An analysis of the American public's reaction to Lindbergh's flight across the Atlantic Ocean.** From: "The Meaning of Lindbergh's Flight" by John W. Ward in *Studies In American Culture*, Joseph J. Kwiat & Mary C. Turpie, eds. (Minneapolis: University of Minnesota, 1960) pp. 27-40. • *6-8, 9-12. Science, English, History, Geography, Social Studies, Psychology*	7 pgs	individualism character pioneer technology
306	**AMERICAN INDIVIDUALISM. Herbert Hoover says it is the basis of our successful democracy and an aspect of our pioneer spirit.** From: "American Individualism" by Herbert Hoover in *Essays on Current Themes*, C. Alphonso Smith, ed. (Boston: Ginn & Company, 923), pp. 391-400. • *4-5, 6-8-9-12. History, Social Studies, Psychology.*	1 pg	individualism character pioneer democracy
307	**FRONTIER SETTLEMENT & AMERICAN GOVERNMENT. A note on how the U.S. Government's resources and sponsorship assisted the opening of the Western frontier.** From: *Wagon Roads West* by William Turrentine Jackson (Berkeley: Univ. of California Press, 1952) pp. 319-328. • *9-12. History, Economics, Government, Social Studies.*	1 pg	pioneer individualism government federal funding
308	**PUBLIC PIONEERS. William Goetzmann on the role of the Army in opening the American West.** From: *Army Exploration in the American West 1803-1863* by William H. Goetzmann (New Haven: Yale Univ. Press, 1963), pp. 59-61 and 372-374. • *9-12. History, Geography, Economics, Government, Social Studies.*	3 pgs	exploration engineer army west federal funding
309	**REALISTIC ROMANTICISM. Richard Darman hails exploration as the key to renewing the American spirit and economy.** From: "Keeping America First: American Romanticism and the Global Economy." A Speech by Richard Darman at Harvard University, May 1, 1990. • *6-8, 9-12. Science, Economics, Government, Social Studies.*	10 pgs	romanticism economy spirit exploration environment
310	**WHY WE EXPLORE. NASA comments on the spiritual and social significance of planetary exploration.** From: *Solar System Exploration Division Strategic Plan, Vol. 1* (Washington, D.C.: National Aeronautics and Space Administration, 1991) pp. 8-10. • *6-8, 9-12. Science, Government, Social Studies, Psychology.*	2 pgs	exploration planet NASA Earth
311	**COST VS. BENEFITS. President Eisenhower voices support for space exploration but concern about its costliness.** From: "Eisenhower: Why I Am a Republican" by Dwight D. Eisenhower in *The Saturday Evening Post*, April 11, 1964. • *4-5, 6-8, 9-12. Science, History, Government*	1 pg	space exploration federal funding prestige government
312	**EXPLORATION AS THE KEY TO GREATNESS. President**	1 pg	space

Nixon says it is vital for America to continue to explore the unknown.
From: "Remarks of President Nixon Following a Tour of the Lyndon B. Johnson Space Center, March 20, 1974" in *Presidential Documents: Richard Nixon 1974, Vol. 10, No. 12,* (Washington, D.C.: U.S. Government Printing Office, 1974) pp. 345-346.
• *6-8, 9-12. History, Social Studies, Psychology.*

science
exploration
unknown
spirit

313 **ON REACHING INTO THE UNKNOWN. President Ford commends America's talisman spirit of adventure.**
From: "Bicentennial of American Independence: President Ford's Remarks at the Dedication Ceremonies for the National Air and Space Museum, July 1, 1976" in *Presidential Documents: Gerald R. Ford, Vol. 12, No. 27* (Washington, D.C.: U.S. Government Printing Office, 1976) pp. 1105-1106.
• *4-5, 6-8, 9-12. Science, History, Economics, Government, Social Studies*

2 pgs

freedom
pioneer
frontier

314 **REMEMBERING APOLLO. President Bush comments on the past and future dreams of U.S. space exploration.**
From: White House press release, July 20, 1989.
• *6-8, 9-12. Science, History, Government.*

4 pgs

Moon
freedom
exploration
mission

315 **THE MOON LANDING NOW. Mark Mullin, Headmaster of St. Albans, describes the impact of this milestone in human history and what it might mean for American education of the 21st century.**
From: "Children of the Moon" in *Educating for the 21st Century: The Challenge for Parents and Teachers* by Mark H. Mullin (Lanham: Madison Books, 1991) pp. 1-12.
• *9-12. Science, Economics, Social Science*

6 pgs

Moon
education
knowledge
Earth
future

316 **COMPUTER EXPLORATION. New trends and attitudes towards using educational technology.**
From: "Voyages to Knowledge in Space Age" by Michel Marriott. Reprinted from *The New York Times,* May 5, 1990.
• *9-12. Science,. Economics, Social Studies.*

3 pgs

space
education
computer
challenge
innovation

317 **COMPARATIVE PLANETOLOGY. Some of the scientific and social reasons for exploring other planets.**
From: "Venus May Tell Us How to Escape Its Fate" by Everett Hafner. Reprinted from *The New York Times,* September 21, 1989.
• *6-8, 9-12. Science, Astronomy, Chemistry, Social Studies*

2 pgs

exploration
planet
Earth

318 **THINKING ABOUT SETI. Flora Lewis muses about the search for extra-terrestrial intelligence.**
From: "Thinking About SETI" by Flora Lewis. Reprinted from *The New York Times,* September 27, 1989.
• *3-5, 6-6, 9-12. Science, Astronomy, Geography, Government, Social Studies, Psychology*

2 pgs

research
federal funding
space
intelligence

319 **FAR FROM THE GENETIC POLICE. Remarks on the potential for human evolution in space.**
From: "The Exploring Animal" by Ben R. Finney and Eric M. Jones in *Interstellar Migration and the Human Experience,* Finney and Jones, eds. (Berkely: U. of Cal. Press, 1985) pp. 15-25. Copyright (c) 1985 The Regents of the University of California.
• *9-12. Science, Biology, Social Studies, Psychology.*

1 pg

space
evolution
intelligence
exploration

320 **ENCOUNTERING THE ICE. Historian Stephen Pyne provides a humanistic perspective on exploring Antarctica: it is what we make of it.** 1 pg
exploration
perspective
ice
Antarctica

From: *The Ice: A Journey to Antarctica*, by Stephen J. Pyne (Iowa City: University of Iowa Press, 1986) pp. 379-388. Copyright 1986 Stephen J. Pyne.

• *6-8, 9-12. Science, Chemistry, English, Geography, Psychology, Art.*

321 **FACING THE FUTURE. J. Robert Oppenheimer on the social history of science.** 8 pgs
knowledge
power
science
society
choice

From: "The Need for New Knowledge" by J. Robert Oppenheimer in *Symposium on Basic Research*, Dael Wolfle, ed. (Washington, D.C.: American Association for the Advancement of Science, 1959) pp. 1-15.

• *9-12. Science, History, Social Studies*

500 **The JASON Project.** 6 pgs

A national educational project to involve teachers and students in deep water scientific explorations. The goal is to provide students with a unique opportunity to take part in live scientific and archaeological exploration. JASON project scientists are interested in motivating students to study science, in deepening students' knowledge of scientific disciplines, and in strengthening students' critical thinking skills. The method is a "world classroom" made possible through Telepresence. Currently, the JASON project is set up in 20 sites (primarily museums) across North America.

501 **USA Today's Visions of Exploration: Past, Present, Future** 3 pgs

Developed in partnership with NASA, this innovative educational project is built around the themes of exploration and space. Using the USA Today newspaper, a curriculum guide, and lesson plans provided daily to teachers, the program seeks to connect historical and current events and to help children use that knowledge to explore social and technological issues of the 21st century. Though designed specifically to encourage student interest in science and space, this national project is interdisciplinary in approach.

\+ 3220 Learning About Astronomy 0 items/no list

\- 3221 Ray Villard's Astronomy Corner 24 items 10/14/92

We are living in a golden age of discovery. Because of the current explosion in knowledge, astronomy textbooks are outdated within just a few years of publication. This bulletin board provides brief news items to give you the latest news of current research in astronomy. These articles are suitable for use in classroom discussion at the middle and high school level. At the introductory astronomy college level they can be used as for homework assignments where students can evaluate the significance of the news item compared to textbook information.

3221 Ray Villard's Astronomy Corner

We are living in a golden age of discovery. Astronomers are making unprecedented advances in our understanding of the origin, evolution and dynamics of the universe. The pace of discovery is driven largely by the advent of space astronomy and powerful new ground-based telescopes.

Because of the current explosion in knowledge, astronomy textbooks are outdated within just a few years of publication. This bulletin board provides brief news items to give you the latest news of current research in astronomy. Many stories feature the findings from the Hubble Space Telescope and other NASA space astronomy

missions.

These articles are suitable for use in classroom discussion at the middle and high school level. At the introductory astronomy college level they can be used as for homework assignments where students can evaluate the significance of the news item compared to textbook information.

Send feedback on these articles to Ray Villard, Space Telescope Science Institute, 3700 Martin Drive, Baltimore, MD 21218, or by fax at 410-338-4579, or by email at villard@stsci.edu.

to observe Mars in detail almost whenever they want to. Space Telescope will help scientists predict such major martian weather events as global dust storms.

309 AURORAE ON JUPITER — 1 pg
Jupiter's magnetic field is far larger and more powerful than earth's, so the electrical fireworks which make aurorae are more spectacular too. Space telescope's ultraviolet sensitivity allows astronomers to filter out Jupiter's glare and focus on the aurorae, which glow brightly in ultraviolet light.

310 BORN AGAIN STARS — 1 pg
Now Hubble Space Telescope has come up with new clues to solving the blue straggler mystery. These stars might rejuvenate themselves and change from old stars back to young stars.

311 DEMOLITION DERBY ON JUPITER — 1 pg
Hubble Space Telescope's pictures of Jupiter reveal new surprises about the Red Spot. The spot pushed around smaller storm that got in it way. These small storms appear on Jupiter as white spots.

312 DIAMONDS IN SPACE — 1 pg
Astronomers first found microscopic diamonds in some meteorites samples in 1987. Ever since then researchers have wondered where the diamonds came from in space. Astronomers estimate that a nearby supernova which exploded in 1987 produced far more diamonds than all the grains of sand on earth's beaches.

313 DISTANCE TO A SUPERNOVA — 1 pg
Space telescope's sharp view provided an accurate measure the ring's angular size on the sky. This means the ring is more than one light-year across. The distance to the supernova, and its host galaxy, the large Magellanic Cloud, turns out to be 169,000 light years.

314 EXTRAGALACTIC JETS — 1 pg
Astronomers suspect that a gigantic black hole, at a galaxy's core, might be the powerhouse behind an extragalactic jet. When seen with Space Telescope's new level of detail, two extragalactic jets observed so far have remarkably different structure.

315 GAMMA RAY BURSTS — 1 pg
The Gamma Ray Observatory discovered that these incredibly powerful gamma ray bursts occur about once a day. Based upon these early observations, researchers speculate that at least one million neutron stars inhabit our galaxy.

316 GAMMA RAY QUASARS — 1 pg
The ultra-high energy beams were detected by NASA's Gamma-ray observatory as coming from quasars, the most distant objects in the universe. These new gamma-ray quasars show the universe if more dynamic and violent than previously imagined.

317 HALO FOR A DEAD STAR — 1 pg
Supernova 1987A was one of the first targets for NASA's Hubble Space Telescope. The space observatory uncovered a ghostly

"footprint" of the original star, the one there before the supernova erupted.

318 INTERGALACTIC CLOUDS 1 pg
Astronomers expected that these primordial clouds became more sparsely scattered as the universe evolved to our present time. So it came as a surprise when NASA's Hubble Space Telescope found some of these clouds in our own galactic back yard, less than a billion light-years away.

319 ON THE TRAIL OF A BLACK HOLE 1 pg
Astronomers recently looked at the location of the suspected black hole that caused the 1991 nova. They found a star like our sun. The star whirls about and invisible companion two and a half times per day at one million miles per hour. A black hole is the most likely explanation for such as massive yet compact object.

320 STARS ON THE REBOUND. 1 pg
NASA's Hubble Space Telescope is peering in the core of globular star clusters to reveal what happens when stars are so tightly crammed together. The space telescope observations suggest that the core is actually on the rebound, like a rubber ball that has been squeezed and then relaxed.

321 THE CASE OF THE MISSING GALAXIES 1 pg
Astronomers have found many faint galaxies lying billions of light-years away. These so called dwarf galaxies are much smaller that galaxies like our Milky Way. The mystery is that very few of these galaxies exist today. So where did they go?

322 THE DOOMSDAY ROCK 1 pg
It's not a question of if the Doomsday Rock will strike, its only a question of when and where. Unlike the dinosaurs we do posses the capability of avoiding our own destruction.

323 WAS MARS ONCE A BLUE PLANET? 2 pgs
billions of years ago Mars was warmer, wetter, and had a thicker atmosphere. Mars was very much like Earth. As carbon dioxide dwindled, so did Mars' warm climate. A global ice age now entombs the planet.

- 3230 Learning About Planetary Exploration 0 items/no list

+ 3300 Teaching Units 0 items/no list

In this section we are attempting to tie together the products of our ExInEd program into teaching and learning packages that we hope will exemplify that which is both useful and enjoyable to teachers and students alike. We are only beginning to experiment with these products and methods of distribution, and we hope that you will provide us with feedback—comments, suggestions, ideas, materials—which we can use to modify these units and correct our approach. For your information, the electronic publications referenced in each of the locations listed below can be downloaded from our electronic bulletin board at 410-516-4880 using your computer and a modem. For information about how to use the bulletin board, see location 1300. Student exercises and learning activities can be accessed directly from the FaxForum.

+ 3310 ?

- 3311 The Hubble Space Telescope 0 items/no list
- 3312 Asteroids, Collisions, and Craters 1 item 12/01/92

23/10